ELECTRICAL MACHINE - I
(ELEC 2201)

Time Allotted : 3 hrs **Full Marks : 70**

Figures out of the right margin indicate full marks.

Candidates are required to answer Group A and any 5 (five) from Group B to E, taking at least one from each group.

Candidates are required to give answer in their own words as far as practicable.

Group – A
(Multiple Choice Type Questions)

1. Choose the correct alternative for the following: **10 × 1 = 10**

(i) To eliminate fifth harmonic voltage from the phase voltage of a generator, the winding of the machine should be short pitched by an electrical angle of
(a) 60^0 (b) 36^0 (c) 45^0 (d) 18^0.

(ii) A DC motor, that can provide zero speed regulation at full load without any controller is
(a) series (b) shunt
(c) cumulative compound (d) differential compound.

(iii) In a DC series generator, the terminal voltage, with increase in load, will
(a) decrease (b) increase
(c) remain same (d) none of these.

(iv) In Swinburn's test of a DC machine,
(a) no load losses are calculated and copper losses are measured
(b) no load losses are measured and copper losses are calculated
(c) both the no-load losses and the copper losses are calculated
(d) both the no-load losses and the copper losses are measured.

(v) Wave winding is employed in a DC machine with
(a) high current and low voltage rating
(b) low current and high voltage rating
(c) high current and high voltage rating
(d) low current and low voltage rating.

(vi) The full load copper loss in a transformer is 1600W. At half load, the loss will be
(a) 400W (b) 1600W
(c) 200W (d) 100W.

(vii) A transformer can have zero voltage regulation at
(a) zero power factor (b) lagging power factor
(c) leading power factor (d) unity power factor.

(viii) Maximum mechanical power is developed in a DC motor when its back EMF is equal to
(a) the applied voltage (b) double the applied voltage
(c) one third of the applied voltage (d) half the applied voltage.

(ix) Open circuit test of a transformer gives
(a) hysteresis loss
(b) eddy current loss
(c) sum of hysteresis loss and eddy current loss
(d) copper loss.

(x) A transformer has full load loss of 900W and copper loss of 1600W. At what percentage of the load, the transformer will have maximum efficiency?
(a) 100% (b) 90% (c) 75% (d) 50%.

Group – B

2. Show that for a singly excited linear electromechanical energy conversion device, electromechanical force developed can be expressed as the negative partial derivative of energy stored in the magnetic field against linear displacement.

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3. (a) Derive the relation between electrical angle and mechanical angle in relation to rotating machines.

(b) What are the advantages of distributing a winding in rotating electrical machines?

(c) Consider a two-pole, three phase star connected AC generator with uniformly distributed winding of total 90 turns. In each of these turns e V (rms) is induced. Calculate the phase and line voltage for the following two cases:
(i) Phase spread is 1200 with full pitch winding.
(ii) Phase spread is 600 with two-third of full pitch winding.

3 + 3 + 6 = 12

Group – C

4. A 230 V DC series motor has an armature resistance of 0.1Ω and series field resistance of 0.1Ω.
   (i) Determine the current required to develop a torque of 60 Nm at 1500 rpm.
   (ii) Determine percentage reduction in flux when the machine runs at 2000 rpm at half the current.

(6 + 6) = 12

5. (a) Explain, with a neat circuit diagram, the Ward-Leonard method of speed control of DC shunt motors.

   (b) During Swinburne's test, a 230 V DC shunt motor takes 2A at no load. Its armature resistance and shunt field resistance are 0.2Ω and 230Ω respectively. Estimate the kW output and efficiency when the motor takes 45A.

(3 + 2) + (4 + 3) = 12

Group – D

6. (a) A 100 kVA single-phase transformer when working at unity pf has an efficiency of 90% at full load and also at half load. Determine the efficiency when it operates at unity pf and 75% of full load.

   (b) A 4 kVA, 200/400 V single phase transformer gave the following test results:

   OC Test (hv side): 200 V 0.8 A 70 W
   SC Test (lv side): 20 V 10 A 60 W

   Calculate the full load and maximum efficiency at 0.8 p.f.

   (c) Why tapping is provided on the hv side of a transformer?

6 + 4 + 2 = 12

7. (a) Find the condition for maximum efficiency in a transformer.

   (b) How to reduce the core loss in a transformer?

   (c) A 22000/2200 V, 600 kVA transformer, having percentage resistance and reactance of 1.5% and 6% respectively, is connected in parallel with a 22000/2200 V, 1200 kVA transformer, having percentage resistance and reactance of 1% and 6.2% respectively, to share a load of 500kW at 0.8 pf lagging. Find the kVA shared by each transformer.

3 + 2 + 7 = 12

Group – E

8. (a) Draw the connection diagram for Yd11.

   (b) Compare the performance of two star-star transformers, one with separate magnetic circuits and the other with the interlinked magnetic circuit.

   (c) Write down the difference between the bank of three single-phase transformers and three-phase core type transformer.

4 + 4 + 4 = 12

9. (a) In a Scott-connected transformer, teaser transformer supplies unity p.f. load of 500 kW at 200 V and the main transformer supplies 0.8 p.f. lagging load of 400 kW at 200 V. For a 3-phase input voltage of 6600 V, determine the primary line currents.

   (b) Draw the connection diagram for Dz0.

7 + 5 = 12